

# **Slurry Transfer at the Idaho National Laboratory**

**Rick Demmer**

**Slurry Retrieval, Pipeline  
Transport, Plugging and  
Mixing Workshop**

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# INTEC/INL/ICPTank Farm Contacts

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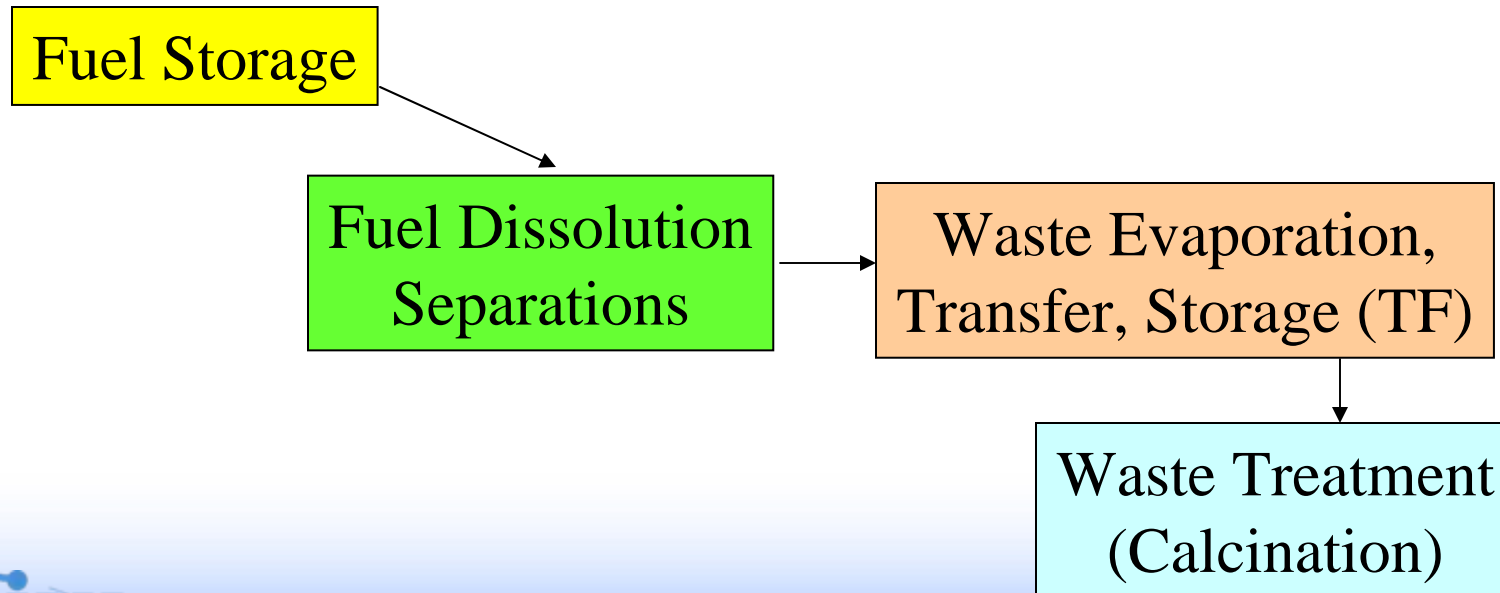
# What is the INL?



AKA: INEL, INEEL

# Systems at the INL (ICP) Tank Farm

- INTEC was an integrated system (microcosm of problems)
  - Fuel Storage Basins
  - Fuel Dissolution and Separations
  - Waste Evaporation Transfer and Storage
  - Waste Treatment (Calcination)







# Common Issues for Reprocessing/TF

- Undissolvable solids (UDS)
  - Nuclear processes create undissolvable materials
  - Nuclear Fuels have complex chemistry/metalurgy
- Continuous (no flange) piping
- Heavy duty construction (Schedule 40-160 all welded)
- Modifications to systems and dusty operations cause plugs
- Miles of “spaghetti” piping in processes
- Treatment and storage of evaporated (high density) solutions
- Chemical compatibility/instability

# INL Tank Farm Differences

- Tanks (ancillary equipment) constructed of 304 SS
- Tanks were small (300,000 gal. nominal)
- Tank Farm is small (11 tanks, 8 empty now)
- Solutions not neutralized, stored as acidic
- Huge effort made **not** to precipitate solids
- Calcination chosen for treatment (some solids compatibility)
- Tanks obstruction free



# Liquid Sampling Analysis

Analyte	WM-180	WM-189
	(mol/L)	(mol/L)
Acid	1.01	2.86
Sodium	2.06	2.04
Aluminum	0.663	0.711
Potassium	0.196	0.225
Sulfur	0.07	0.086
Calcium	0.047	0.073
Iron	0.022	0.027
Nitrate	5.01	6.52
Sulfate	0.05	0.19
Solids Quantity	3%	1%

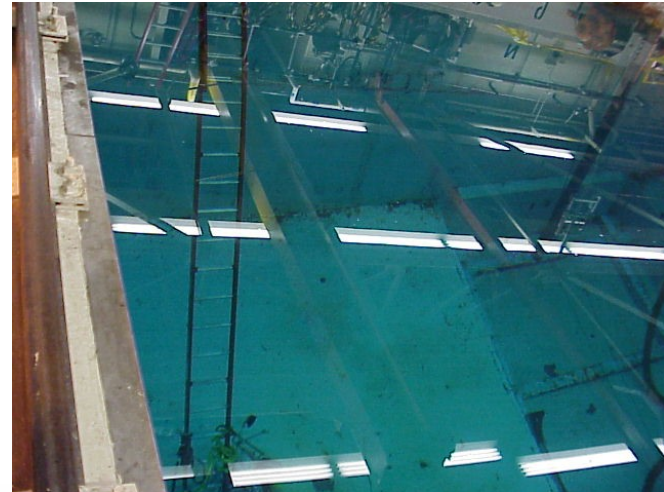
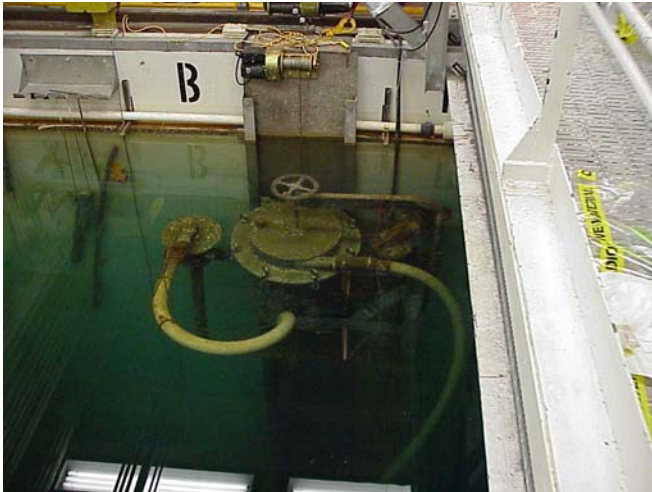


# Slurry Properties

Analyte	WM-180	WM-189	Units
Intersitital Water	80	70	%
Particle Size (med)	10	30	um
Particle Dist	2-70	2-200	um
Settling rate	Slow (0.5)	Fast (5)	m/hr
S Viscosity	2.2	1.9	cP
NaNO3	62	29	%
Al(NO3)	17	27	%
K3H6Al5(PO4)8	-	13	%
KNO3	7	-	%
FePO4	-	5	%
Al2O3	5	-	%
Zr(HPO3)2	3	-	%
SiO2	-	5	%
Sr(89+90)	1.00E-04	6.00E-05	Ci/g
Cs-137	1.40E-04	2.60E-04	Ci/g
Pu-238	2.20E-06	8.70E-05	Ci/g

# Spent Fuel Pools?

- Though we don't deal with them much, SFPs may be a major source of solids
  - Resins and filters from basin cleanup systems
  - Fuel material CRUD
  - Blown in dirt, debris and algae



# Dissolution/Separation Plugs

- Dissolution of total fuel rods, some undissolvable solids
  - Fission type solids
  - Centrifugation for solids removal
  - Some use of filtration

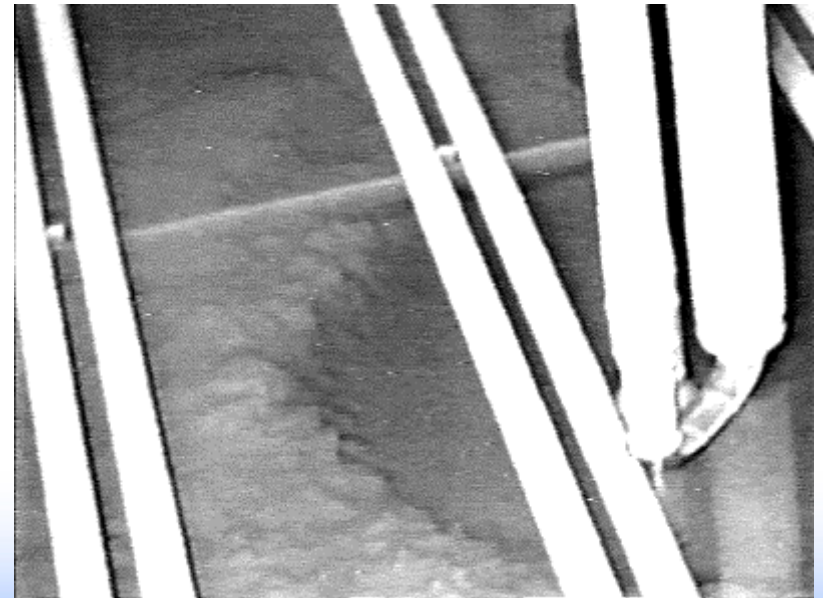
# INL Plugs in Tank Farm

- INL has few TF plugs
  - Acidic waste solutions (not neutralized)
  - Stainless Steel (304L) construction
  - Small amount of UDS (WM-183)
  - Alternative, redundant, backup systems
- Plugs are generally in instrument probes



# INL TF Solids Handling + Retrieval

- Not stir up solids in tank farms
  - Static solids in bottom of tanks
- Leave in tank while treating liquid
- Specially equipped slurry transfer for retrieval
  - Wash Ball (spin jet system) and hand nozzle
  - Steam jet removal (replaced steam jet for higher flow)





# TF Plugging Case 1, Valve Positioning

- Valve on 3" pipe did not open fully (globe valve not ball valve)
- Solids clogged restricted passage
- Valve was removed and repaired, system returned to normal





# TF Case 2, Silica Gel

- Silica Gel Ruthenium Absorbers on the NWCF
- Periodically rinsed to regenerate ( $\text{HNO}_3$ )
- Silica gel degenerates (decrepitates!)
- Transfer from NWCF to TF of regeneration solution caused blockage in complicated “trombone” pipe section.

# Evaporator (PEW) plugs

- Most low level solution waste from process equipment is sent to evaporator (PEW)
  - Thermo-siphon evaporator
  - Receives wastes from all over plant
- Complicated chemistries begin to prevail under evaporation (sometimes past solubility limits)
- Solids from concrete degradation and removal
- Evaporator systems become scaled

# Calcination Plugs

- Most plugs occurred in instrumentation lines
  - Generally cleared with HP air (“minipump” 1000 psi)
- Some plugs in feed nozzles
  - Small orifice, generally campaigned with others (built-in backups)
- Some plugs in calcine system
  - Calcine agglomeration
    - Dissolution with nitric acid
    - Some pipe sections had to be removed (shutdown and cleanout)



# Summary

- SS construction, redundancy, acidic solutions
- Integration of processing and management of solutions to avoid solidification

